Potential Energy of a Spring:

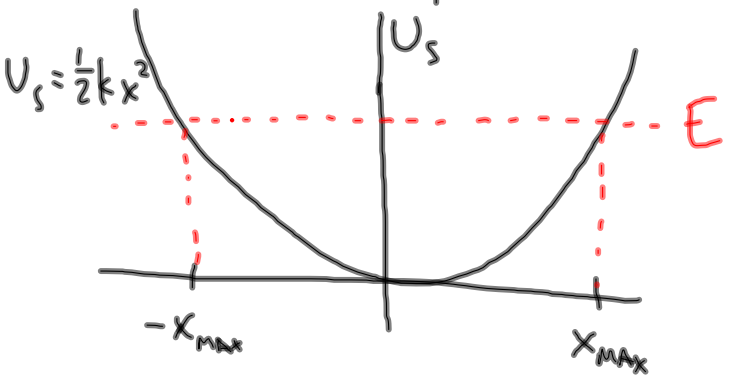
$$U_s = \frac{1}{2} k x^2$$

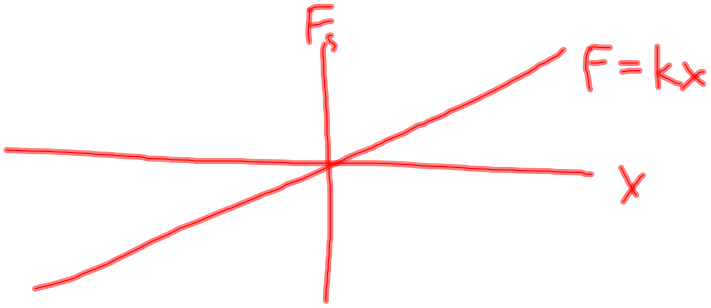
- x → displacement from natural length
- k → spring constant
- U_s → potential energy of a spring

Relationship bet. F and U

$$F_s = -kx \qquad U_s = \frac{1}{2} k x^2$$

force is rate of change of energy





- In general, energy is conserved.
  - Work
  - Mechanical waves
  - Heat
  - Matter transfer
  - Electrical transmission
  - Electromagnetic radiation

$$\Delta E_{system} = \sum T$$
$$\hookrightarrow \text{transfer}$$

$$\Delta K + \Delta U + E_{int} = W + Q + T_{MW} + T_{MT} + T_{ET} + T_{ER}$$

- Simplifies considerably for an isolated system.
  - isolated system is when no energy crosses the system boundary
  - $W = \Delta K + \Delta U$
  - if no work, $\Delta K + \Delta U = 0$

$$(K_f - K_i) + (U_f - U_i) = 0$$

$$K_i + U_i = K_f + U_f$$

A ball of mass *m* is dropped from a height *h* above the ground. Neglecting air resistance, determine the speed of the ball when it is at a height *y* above the ground.

Conservation of Energy of an Isolated System:

$$E_i = E_f$$

$$K_i + U_{ig} = K_f + U_{fg}$$

$$\frac{1}{2}mv_i^2 + mgh_i = \frac{1}{2}mv_f^2 + mgh_f$$

($\frac{1}{2}mv_i^2 \to 0$)

$v_i = 0$ m/s

$h_f = y$

$h_i = h$

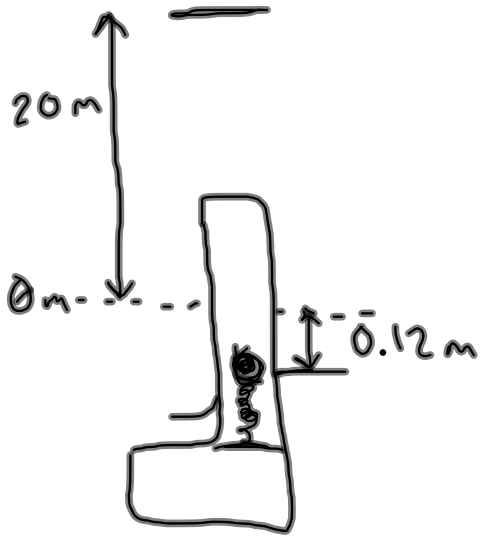
$$v_f = \sqrt{\frac{2}{m}(mgh - mgy)}$$

$$= \sqrt{2g(h-y)}$$

The launching mechanism of a popgun consists of a spring of unknown spring constant. When the spring is compressed 0.120 m, the gun, when fired vertically, is able to launch a 35.0 g projectile to a maximum height of 20.0 m above the position of the projectile as it leaves the spring.

a) Neglecting all resistive forces, determine the spring constant.

b) Find the speed of the projectile as it moves through the equilibrium position of the spring.



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A 6.0 kg block initially at rest is pulled to the right along a horizontal surface by a constant horizontal force of 12 N. Find the speed of the block after it has moved 3.0 m if the surfaces in contact have a coefficient of kinetic friction of 0.15.